CLAIMS

WHAT IS CLAIMED IS:

1. A method for making a thin film device, said method comprising the steps of:

(a) implanting hydrogen to a selected depth within a single crystal semiconducting material substrate to form a hydrogen ion layer so as to divide the single crystal substrate into two distinct portions;

(b) bonding the single crystal semiconducting material substrate to a flexible substrate; and

(c) splitting the single crystal semiconductor substrate along the implanted ion layer and removing the portion of the growth substrate, which is on the side of the ion layer away from the flexible substrate, wherein a remaining thin film portion is attached to the flexible substrate.

2. A method according to claim 1, wherein the single crystal semiconductor substrate further comprises a material selected from a group consisting of silicon, germanium, InP, and GaAs.

3. A method according to claim 1, wherein the flexible substrate comprises a material selected from a group consisting of stainless steel foil, plastic, polyimide, polyester, and mylar.

4. A method according to claim 1, further comprising the step of :

depositing a stiffening material layer on the surface of the single crystal substrate.

5. A method according to claim 1, further comprising the step of:

directing a high pressure nitrogen gas steam or liquid stream towards the side of the single crystal substrate into which a high dose hydrogen ion implantation has been made to split the single crystal substrate.

6. A method according to claim 1, further comprising the step of:

implanting boron at the same selected depth as the implanted hydrogen for lowering the thermal energy required to split the growth substrate.

7. A method according to claim 1, further comprising the step of:

providing an adhesive layer between the bonding surfaces of the thin film functional layer and the flexible substrate before or during step (b) for improving the bonding thereof.

8. The method according to claim 1, wherein the single crystal semiconductor substrate contain etch stop layers, and wherein the peak of the hydrogen ion implant resides at a depth beyond the etch stop layer.

9. A method according to claim 1, further comprising the step of:

smoothing the split silicon surface.

10. A method for making a thin film device, said method comprising the steps of:

(a) depositing at least one protective layer on one surface of a large diameter growth substrate;

(b) growing a film layer of thin film functional material on the at least one protective layer, said functional material comprising a material selected from the group consisting of high temperature superconducting (YBCO), ferroelectric, piezoelectric, pyroelectric, high dielectric constant, electro-optic, photoreactive, waveguide, non-linear optical, superconducting, photodetecting, solar cell, wideband gap, shaped memory alloy, and electrically conducting materials;

(c) implanting hydrogen to a selected depth within the growth substrate or within the at least one protective layer to form a hydrogen ion layer so as to divide the material having the

growth substrate and the at least one protective layer into distinct portions;

(d) bonding the growth substrate including the at least one protective layer and the thin film layer to a second flexible substrate; and

(e) splitting the material having the growth substrate and the at least one protective layer along the implanted ion layer and removing the portion of the material which is on the side of the ion layer away from the flexible substrate.

11. A method according to claim 10, wherein the growth substrate is comprised of a material selected from a group consisting of silicon, GaAs, quartz, and sapphire.

12. A method according to claim 10, wherein the growth substrate comprising silicon.

13. A method according to claim 10, further comprising the step of:
depositing a stiffening material layer on the surface of the single crystal substrate.

14. A method according to claim 10, further comprising the step of:
directing a high pressure nitrogen gas steam or liquid stream towards the side of the single crystal substrate into which a high dose hydrogen ion implantation has been made to split the single crystal substrate.

15. A method according to claim 10, wherein the growth substrate comprising silicon, wherein the at least one protective layer comprising an oxide layer, an adhesion layer, and a barrier layer; and wherein the method further comprising the steps of;
depositing the oxide layer on the silicon substrate;
depositing the adhesion layer on the oxide layer; and
depositing the barrier layer on the adhesion layer for isolating the thin film layer.

16. A method according to claim 15, wherein the adhesion layer is comprised of titanium, and wherein the barrier layer comprises a material selected from a group consisting of platinum and iridium.

17. A method according to claim 10, the at least one protective layer comprising MgO.

18. A method according to claim 10, wherein the thin film functional material is comprised of a material selected from a group consisting of a single crystal material, a polycrystalline material, and a high temperature sinter ceramic material.

19. A method according to claim 10, wherein the flexible substrate further comprises a material selected from a group consisting of stainless steel foil, plastic, polyinide, polyester, and mylar.

20. A method according to claim 10, further comprising the step of:

annealing the thin film functional material layer for strengthening and tempering the thin film layer.

21. A method according to claim 10, further comprising the step of:

implanting boron at the same selected depth as the implanted hydrogen for lowering the thermal energy required to split the growth substrate.

22. A method according to claim 10, further comprising the step of:

providing an adhesive layer between the bonding surfaces of the thin film functional layer and the flexible substrate before or during step (d) for improving the bonding thereof.

23. A method for making a thin film device, said method comprising the steps of:

(a) growing a film layer of thin film functional material on the surface of a growth substrate, said functional material comprising a material selected from the group consisting of high temperature superconducting (YBCO), ferroelectric, piezoelectric, pyroelectric, high dielectric constant, electro-optic, photoreactive, waveguide, non-linear optical, superconducting, photodetecting, solar cell, wideband gap, shaped memory alloy, and electrically conducting materials;

(b) implanting hydrogen to a selected depth within the growth substrate to form a hydrogen ion layer so as to divide the growth substrate into distinct portions;

(c) bonding the growth substrate and associated material having the thin film layer to a second flexible substrate;

(d) splitting the material having the growth substrate and thin film material along the implanted ion layer and removing the portion of the material which is on the side of the ion layer away from the flexible substrate.

24. A method according to claim 23, further comprising the step of:

depositing a stiffening material layer on the surface of the single crystal substrate.

25. A method according to claim 23, further comprising the steps of:

directing a high pressure nitrogen gas steam or liquid stream towards the side of the single crystal substrate into which a high dose hydrogen ion implantation has been made to split the single crystal substrate.